Finescale Water-Mass Variability from ARGO Profiling Floats

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LONG TERM GOALS

My main interests are in smallscale ocean physics processes that contribute to stirring and mixing in order to understand and parameterize their impact on larger scales. This includes phenomena ranging from the microscale (1 cm) up to the mesoscale (10-100 km).

OBJECTIVES

These funds are to be used to explore finescale water-mass variability in ARGO float data with particular attention to horizontal and temporal coherence in finestructure and finescale density ratios $R_\rho = -\alpha T_z/\beta S_z$.

APPROACH

ARGO profiling float data is being downloaded from its archive and catalogued. Temperature T and salinity S data will be used to compute density σ_θ, density ratio R_ρ and stratification N^2. Time/space means will be computed on isopycnals and water-mass anomaly statistics and vertical wavenumber spectra relative to these means accumulated. Coherence of the spectral quantities will be examined laterally and temporally with the expectation that the finescale will be incoherent on even short horizontal and time scales (Ferrari and Polzin 2005). Given the limited funding available and the effort required for initial cataloging of the data, analysis will focus on the North (Arabian Sea, Bay of Bengal) and equatorial Indian Ocean because of ONR's interest in this region, and the Okinawa Trough for comparison with glider data collected by Craig Lee for the Kuroshio QPE. Time and resources permitting, the data cataloging and analysis will expand to the whole Indian Ocean.

WORK COMPLETED

Profile data from 1999-2011 have been downloaded from the ARGO float website from the Indian Ocean and Okinawa Trough. Software has been written for a first look at the data in the Bay of Bengal and Arabian Sea (Fig. 1).

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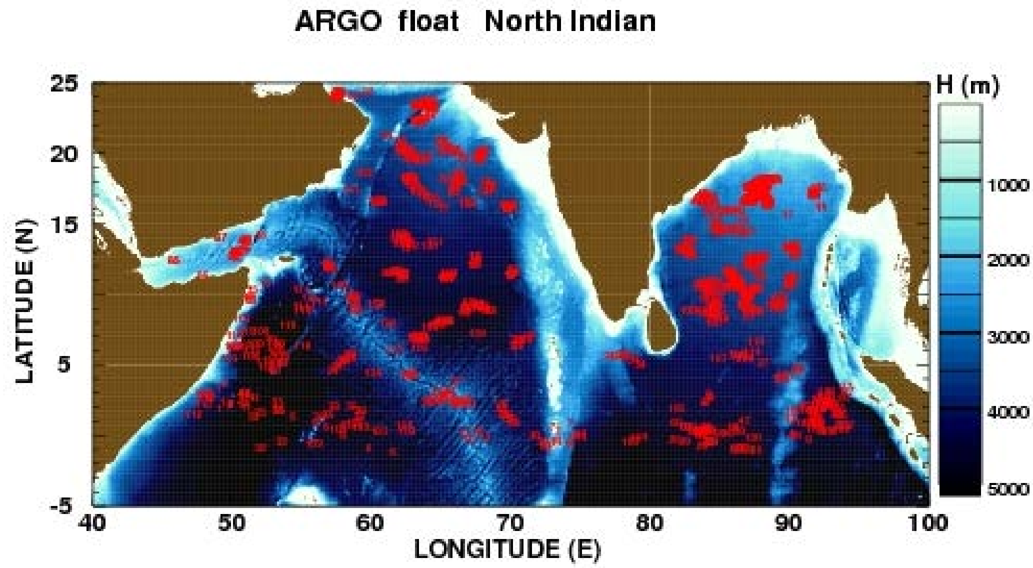

Figure 1: ARGO float profile locations from the Arabian Sea, Bay of Bengal and equatorial Indian Ocean from 1999-2011 with underlying bathymetry in the background.

RESULTS

Preliminary examination of the density ratio $R_\rho = -\alpha T_z/\beta S_z$ as a function of density sq in the North and equatorial Indian Ocean (Fig. 2) finds double-diffusively stable, salt-fingering-favorable and diffusively-unstable conditions present in the Arabian Sea, along the equator and in the Bay of Bengal. Strongly salt-fingering-favorable conditions ($1 < R_\rho < 2$) are 10-20% of the profiles at some density surfaces at all locations. Stable conditions predominate in the west and central equatorial while fingering-favorable stratification is more pervasive in the eastern equatorial Indian Ocean and Bay of Bengal. This is surprising since the Arabian Sea is a net evaporative basin and the Bay of Bengal a net precipitative basin so one would expect just the opposite.

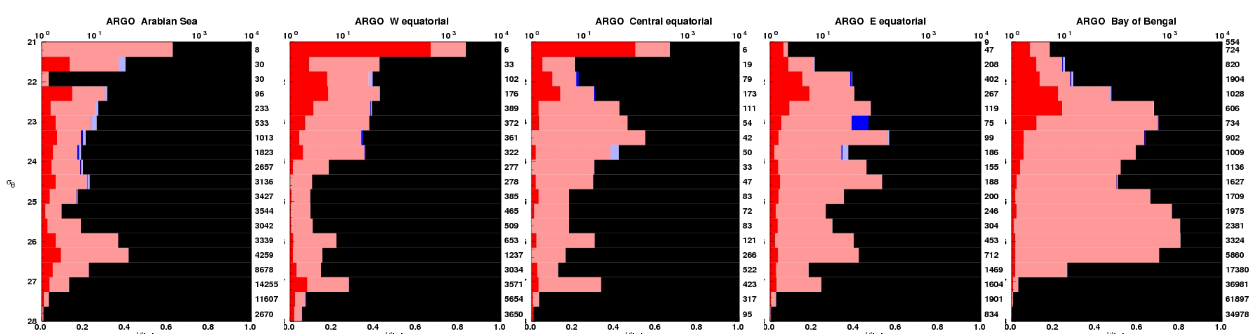

Figure 2: Density ratio $R_\rho = -\alpha T_z/\beta S_z$ statistics as a function of density σ_θ from the Arabian Sea (left), from the western to eastern equatorial Indian Ocean (middle) to the Bay of Bengal (right). Strongly salt-fingering favorable ($1 < R_\rho < 2$) is red, weakly salt-fingering ($R_\rho > 2$) pink, strongly diffusively-unstable ($0.5 < R_\rho < 1$) blue and weakly diffusively-unstable ($0 < R_\rho < 0.5$) light blue and double-diffusively stable ($R_\rho < 0$) black,. Numbers along the right axes indicate the number of data points going into each σ_θ bins estimates. The bulk of all the regions is either double-diffusively stable (black) or fingering-favorable (red and pink).

IMPACT/APPLICATION

The implication of the results in Fig. 2 is that analysis based on climatologically-averaged products such as the Levitus atlas (e.g., You 2002) are missing finescale water-mass variability that may lead to underestimating the mixing due to double diffusion and is an important signature of stirring along isopycnals. Such finescale variability also impacts acoustic propagation.

RELATED PROJECTS

This project attempts to determine more global implications of finescale water-mass variability being investigated in ONR's LatMix DRI to better parameterize lateral stirring and mixing on lengthscales smaller than 100 km.

REFERENCES

Ferrari, R., and K.L. Polzin, 2005: Finescale structure of the *T-S* relation in the eastern North Atlantic. *J. Phys. Oceanogr*., **35**, 1437-1454.

You, Y., 2002: A global ocean climatological atlas of the Turner angle: Implications for double-diffusion and water-mass structure. *Deep-Sea Res. I*, **49**, 2075-2093.

PUBLICATIONS

N/A